NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
ESDS Reuse Working Group

REUSE READINESS LEVELS AS A MEASURE OF SOFTWARE REUSABILITY

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Developers and adopters (reusers) of software share a common need to evaluate software and related assets for potential reuse. Common measures of technology maturity often neglect reusability, an important issue to consider since software reuse can save time, save money, and increase the reliability of resulting products. Other models for assessing software maturity have not been widely accepted, so the NASA Earth Science Data Systems (ESDS) Software Reuse Working Group (WG) is developing Reuse Readiness Levels as an alternative model.

The Working Group considered the following nine topic areas considered important for measuring reuse maturity:

- *Documentation*
- *Extensibility*
- *Intellectual Property Issues*
- *Modularity*
- *Packaging*
- *Portability*
- *Standards Compliance*
- *Support*
- *Verification/Testing*

The WG created levels for these topic areas. At least two members worked on each area's levels, with feedback from the full WG. After developing a set of levels for each topic area, the WG collaborated to create this draft of a single, unified scale for measuring reuse maturity. This was done by cross-comparing the levels for each topic area and deciding on a description that captures the essence of all of the topic area levels combined.

Draft Reuse Readiness Level Summaries

Level	Summary	Description
RRL 1	No reusability; the software is not reusable.	Little is provided beyond limited source code or pre-compiled, executable binaries. There is no support, contact information for developers or rights for reuse specified, the software is not extensible, and there is inadequate or no documentation.
RRL 2	Initial reusability; software reuse is not practical.	Some source code, documentation, and contact information are provided, but these are still very limited. Initial testing has been done, but reuse rights are still unclear. Reuse would be challenging and cost-prohibitive.
RRL 3	Basic reusability; the software might be reusable by skilled users at substantial effort, cost, and risk.	Software has some modularity and standards compliance, some support is provided by developers, and detailed installation instructions are available, but rights are unspecified. An expert may be able to reuse the software, but general users would not.
RRL 4	Reuse is possible; the software might be reused by most users with some effort, cost, and risk.	Software and documentation are complete and understandable. Software has been demonstrated in a lab on one or more specific platforms, infrequent patches are available, and intellectual property issues would need to be negotiated. Reuse is possible, but may be difficult.
RRL 5	Reuse is practical; the software could be reused by most users with reasonable cost and risk.	Software is moderately portable, modular, extendable, and configurable, has low-fidelity standards compliance, a user manual, and has been tested in a lab. A user community exists, but may be a small community of experts. Developers may be contacted to request limited rights for reuse.
RRL 6	Software is reusable; the software can be reused by most users although there may be some cost and risk.	Software has been designed for extensibility, modularity, and portability, but software and documentation may still have limited applicability. Tutorials are available, and the software has been demonstrated in a relevant environment. Developers may be contacted to obtain formal statements on restricted rights or to negotiate additional rights.
RRL 7	Software is highly reusable; the software can be reused by most users with minimum cost and risk.	Software is highly portable and modular, has high-fidelity standards compliance, provides auto-build installation, and has been tested in a relevant environment. Support is developer-organized, and an interface guide is available. Software and documentation are applicable for most systems. Brief statements are available describing limited rights for reuse and developers may be contacted to negotiate additional rights.
RRL 8	Demonstrated reusability; the software has been reused by multiple users.	Software has been shown to be extensible, and has been qualified through test and demonstration. An extension guide and organization-provided support are available. Brief statements are available describing unrestricted rights for reuse and developers may be contacted to obtain formal rights statements.
RRL 9	Proven reusability; the software is being reused by many classes of users over a wide range of systems.	Software is fully portable and modular, with all appropriate documentation and standards compliance, encapsulated packaging, a GUI installer, and a large support community that provides patches. Software has been tested and validated through successful use of application output. Multiple statements describing unrestricted rights for reuse and the recommended citation are embedded into the product..

Some factors/questions already under consideration for future revisions to refine the levels into a more practical, usable form include:

- *Security* – Could this be incorporated into verification/testing, should it be its own topic area, or is it not a factor of reusability?
- *Use vs. reuse* – When is a factor more about how good it is for your application (use) than is it ready for you to use (reuse)?
- *Quantitative measures* – to make the ratings easier to determine, with less ambiguity, more objective level criteria are needed.
- *Cost and Risk* – how to factor in these concerns?
- *Topic level ratings* – these are viewed as useful information for reusers, so how should the information be offered?

Recommended improvements for the RRLs and/or topic area levels:

- *Readability* – Replace technical terms in topic area levels with simpler language
- *Measurability* – Specify measurable tests for attaining each level within topic areas
- *Normalization* – Greater consistency is needed across levels and within topic areas
- Questions on descriptions of levels within topic areas revealed several challenges

Potential uses for the RRLs include:

- Comparing software assets for potential reuse
- Determining cost of reusing software assets
- Metadata for reusable software assets stored in catalogs and repositories, as a guide to reusers
- An indicator of areas to focus on when creating reusable assets, as a guide to providers
- Part of requests for proposals or contracts, asking for reuse approach or how assets are being made reusable
- Initially developed for Earth science, but general enough to be used in any domain

For more information, please visit:
http://www.esdswg.com/softwarereuse